METHOD FOR CONTROLLING A COOKING PROCESS ON A CERAMIC HOB, AND CERAMIC HOB FOR CARRYING OUT SAID METHOD

CROSS REFERENCE TO PRIOR APPLICATION

This is a U.S. national phase application under 35 U.S.C. §371 of International Patent Application No. PCT/EP2005/000122, filed January 10, 2005, and claims benefit of German Patent Application No. 10 2005 002 058.2, filed January 15, 2004 which is incorporated by reference herein. The International Application was published in German on July 28, 2005 as WO 2005/069693 A1 under PCT Article 21(2).

FIELD OF THE INVENTION

[0001] The present invention relates to a method for controlling a cooking process on a cooktop for controlling a cooking process on a cooktop including a cooktop plate.

[0002] A method for controlling a cooking process on a cooktop including a cooktop plate is described, for example, in German Patent Application DE 198 56 140 A1. The known method controls a cooking process on a cooktop including a cooktop plate which is made, in particular, of glass ceramics and which has a material thickness s defined by a flat upper surface and a flat lower surface, in a direction perpendicular to the main directions of extension of said upper and lower surfaces, further including at least one cooking zone that can be heated by a heating means located beneath the cooktop plate when the cooktop is in the installed position, and further including an electrical control system for controlling the heat output of the heating means, and further including a first heat sensor unit located beneath the cooktop plate.

[0003] In order to allow the heat output of the heating means to be controlled independently of a cooking utensil placed on the cooking zone, the known method proposes that a processing unit forming part of the electrical control system and taking the form of an arithmetic unit compare the output signal of the first heat sensor unit to measurement system data stored in a memory of the electrical control system, and that the heat output of the heating means be controlled as a function of a comparison value obtained from this comparison.

[0004] In the known method, it is considered essential that the first heat sensor unit be designed to receive only or substantially only the thermal radiation emitted from the lower

surface of the cooktop plate, and that the temperature of the cooking utensil placed on the cooking zone is then inferred therefrom and/or controlled on this basis. To this end, the known system includes a cooktop plate whose transmittance, at least in the sensing region of the first heat sensor unit and at least in the spectral measuring range thereof, is less than 30 %.

SUMMARY

[0005] It is, therefore, an object of the present invention to provide a method for controlling a cooking process on a cooktop, in which the influence of the cooking utensil is taken into account.

[0006] In an embodiment, the present invention provides a method for controlling a cooking process on a cooktop including: a cooktop plate having, in a direction perpendicular to the main directions of extension of the upper and lower surfaces, a material thickness defined by a flat upper surface and a flat lower surface; at least one cooking zone heatable by a heating device disposed beneath the cooktop plate when the cooktop is in an installed position; and a first and a second heat sensor unit disposed beneath the cooktop plate. The method includes:

measuring, by the first heat sensor unit, a first heat flow emanating downward substantially from the cooktop plate in an area of a first cooking zone of the at least one cooking zone;

measuring, by the second heat sensor unit, a second heat flow emanating downward, in the area of the first cooking zone, downward substantially from the cooktop plate and a cooking utensil disposed thereon;

calculating, by an electrical control system, a comparison value from respective output signals of the first and second heat sensor units;

comparing, by the electrical control system, the calculated comparison value with at least one predetermined and stored reference value; and

controlling, by the electrical control system, a heat output of the heating device as a function of the comparing.

[0007] In addition to improved control of a cooking process on a cooktop, a particular advantage that can be achieved with the present invention is the improved accuracy and speed in the control of the actual temperature of the cooking utensil.

[0008] In principle, it is possible for the first heat sensor unit to detect, for example, only the portion of heat flow that emanates downward from the cooktop plate by thermal conduction, the detection being performed, for example, using a contact temperature sensor. Advantageously, in accordance with the method of the present invention, the first and second heat sensor units detect the thermal radiation as a part of the respective heat flow.

[0009] One advantageous refinement of the method according to the present invention proposes that, for purposes of controlling the cooking process, in addition, the emissivity of the bottom of a cooking utensil placed on the cooking zone be determined using an additional heat sensor unit. In this manner, the accuracy in the control of the cooking process is further improved. Moreover, based on the emissivity so determined, the temperature of the bottom of the cooking utensil can be automatically determined, also with improved accuracy.

[0010] Another, alternative object of the present invention is to provide a cooktop for carrying out the method of the present invention.

[0011] In an embodiment, the present invention also provides a cooktop comprising:

a cooktop plate having, in a direction perpendicular to the main directions of extension of the upper and lower surfaces, a material thickness defined by a flat upper surface and a flat lower surface;

at least one cooking zone heatable by a heating device disposed beneath the cooktop plate when the cooktop is in an installed position;

a first heat sensor unit disposed beneath the cooktop plate and configured to measure a first heat flow emanating downward substantially from the cooktop plate in an area of a first cooking zone of the at least one cooking zone;

a second heat sensor unit disposed beneath the cooktop plate and configured to measure a heat flow emanating downward substantially from the cooktop plate and a cooking utensil disposed thereon in the area of the first cooking zone; and

an electrical control system including a processing unit and a memory, the processing unit being configured to generate a comparison value from respective output signals of the first and second heat sensor units, the electrical control system being configured to control a heat output of the heating device as a function of a comparison of the comparison value with at least one predetermined reference value stored in the memory.

[0012] In addition to improved control of a cooking process on a cooktop, a particular advantage that can be achieved with the present invention is the improved accuracy and speed in the control of the actual temperature of the cooking utensil.

[0013] The first heat sensor unit can, in principle, be selected within wide suitable limits in terms of type, arrangement, and measuring range. However, in a particularly simple implementation of the first heat sensor unit, and thus of the cooktop of the present invention, the first heat sensor unit includes a contact temperature sensor.

[0014] In an advantageous refinement of the teaching according to the present invention, it is proposed that the measuring range of the first heat sensor unit be limited to the measurement of thermal radiation in a first wavelength range, and that in the area of the cooking zone, at least in the sensing region of the first heat sensor unit, the cooktop plate have a transmittance of less than 20 % for thermal radiation of the first wavelength range. This ensures that in the area of the cooking zone, the first heat sensor unit detects substantially only the thermal radiation that is emitted downward by the cooktop plate alone.

[0015] An advantageous refinement of the aforementioned embodiment proposes that, at least in the sensing region of the first heat sensor unit, the transmittance of the cooktop plate for thermal radiation of the first wavelength range be approximately 0 %. This ensures that in the area of the cooking zone, the first heat sensor unit detects substantially only the thermal radiation that is emitted downward by the lower surface of the cooktop plate.

[0016] In an advantageous refinement of the teaching according to the present invention, it is proposed that the measuring range of the second heat sensor unit be limited to the measurement of thermal radiation in a second wavelength range, which is different from the first wavelength range, and that in the area of the cooking zone, at least in the sensing region of the second heat sensor unit, the cooktop plate have a transmittance greater than 20 % for thermal radiation of the second wavelength range. This ensures that in the area of the cooking zone, the second heat sensor unit detects substantially the thermal radiation that is emitted downward by the cooktop plate and the cooking utensil placed thereon.

[0017] An advantageous refinement of the aforementioned embodiment proposes that, at least in the sensing region of the second heat sensor unit, the transmittance of the cooktop

plate for thermal radiation of the second wavelength range be at least about 50 %. In this manner, the measurement performed by the second heat sensor unit is further improved because of a higher input signal to the second heat sensor unit.

[0018] In one advantageous refinement of the present invention, the first and second heat sensor units are designed to measure thermal radiation and have at least some components in common, in particular a shared heat sensor. In this manner, for example, the number of heat sensors needed is reduced.

[0019] In another advantageous refinement of the present invention, the material thickness s of the cooktop plate is reduced at least in the sensing region of the second heat sensor unit. Thus, the influence that the heat flow emanating downward from the cooktop plate alone has on the heat flow that emanates downward from the cooktop plate and the cooking utensil placed thereon is reduced in a simple manner.

[0020] A advantageous refinement of the aforementioned embodiment proposes that, at least in the sensing region of the second heat sensor unit, the cooktop plate be designed as a converging lens in a direction from the cooktop plate toward the second heat sensor unit. In this manner, the number of components is further reduced.

[0021] In another advantageous refinement of the teaching according to the present invention, at least one deflector means is disposed in the optical path from the cooktop plate and/or the bottom of the cooking utensil to the first and/or second heat sensor unit(s). This allows the first and/or second heat sensor unit(s) to be positioned independently of the spatial position of the cooking zone, for example, at a cooler location of the cooktop, especially in the edge region of the cooktop, in a structurally simple manner.

[0022] In yet another advantageous refinement of the teaching according to the present invention, the second heat sensor unit has an optical filter disposed in the optical path from the cooktop plate and/or the bottom of the cooking utensil to the second heat sensor unit, said optical filter being made of the same material as the cooktop plate. The materials suitable for cooktop plates, in particular glass-ceramics, are less expensive to purchase compared to, for example, spectrally selective optical filters for limiting the measuring range of the second heat sensor unit.

[0023] One advantageous refinement of the teaching according to the present invention proposes that the emissivity of the bottom of a cooking utensil placed on the cooking zone be able to be determined using the second heat sensor unit. In this manner, the accuracy in the control of the cooking process is further improved. Moreover, based on the emissivity so determined, the temperature of the bottom of the cooking utensil can be automatically determined, also with improved accuracy. The emissivity of the bottom of a cooking utensil placed on the cooking zone can, in principle, be determined using an additional heat sensor unit, which is different from the second heat sensor unit. However, using the second heat sensor unit further reduces the number of components.

[0024] One advantageous refinement of the aforementioned embodiment, proposes that a third heat sensor unit be provided whose measuring range is limited to the measurement of thermal radiation in a third wavelength range, which is different from the second wavelength range, and that in the area of the cooking zone, at least in the sensing region of the third heat sensor unit, the cooktop plate have a transmittance greater than 20 % for thermal radiation of the third wavelength range. This further improves the accuracy in the determination of the emissivity of the bottom of a cooking utensil placed on the cooking zone, and thus, the accuracy in the control of the cooking process.

[0025] In another advantageous refinement of the teaching according to the present invention, it is proposed that in the sensing region of the first heat sensor unit, the cooktop plate be provided on its upper surface with a coating having a transmittance of approximately 0 %. This helps ensure that in the sensing region of the first heat sensor unit, the first heat sensor unit detects substantially only the thermal radiation that is emitted downward by the cooktop plate, independently of the transmittance of the cooktop plate.

[0026] In an advantageous refinement of the aforementioned embodiment, the coating has a reflectance of about 100 %. Thus, the coating is implemented in a simple manner.

[0027] In an alternative refinement of the aforementioned embodiment, the coating has an absorptance of about 100 %. Here too, it is ensured that in the sensing region of the first heat sensor unit, the first heat sensor unit detects substantially only the thermal radiation that is

emitted downward by the cooktop plate, independently of the transmittance of the cooktop plate.

[0028] Yet another, alternative object of the present invention is to provide a system for carrying out the method of the present invention.

[0029] In an embodiment, the present invention also provides a system comprising: a cooktop and a cooking utensil disposed thereon, the cooktop including:

a cooktop plate having, in a direction perpendicular to the main directions of extension of the upper and lower surfaces, a material thickness defined by a flat upper surface and a flat lower surface;

at least one cooking zone heatable by a heating device disposed beneath the cooktop plate when the cooktop is in an installed position;

a first heat sensor unit disposed beneath the cooktop plate and configured to measure a first heat flow emanating downward substantially from the cooktop plate in an area of a first cooking zone of the at least one cooking zone;

a second heat sensor unit disposed beneath the cooktop plate and configured to measure a heat flow emanating downward substantially from the cooktop plate and the cooking utensil, the cooking utensil being disposed in the area of the first cooking zone;

an electrical control system including a processing unit and a memory, the processing unit being configured to generate a comparison value from respective output signals of the first and second heat sensor units, the electrical control system being configured to control a heat output of the heating device as a function of a comparison of the comparison value with at least one predetermined reference value stored in the memory; and

a coating disposed on a bottom of the cooking utensil, at least in an area that overlaps a sensing region of the second heat sensor unit, the coating having a predetermined emissivity;

wherein the memory of the electrical control system is configured to store the predetermined emissivity.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] An exemplary embodiment of the present invention is shown in the drawings in a schematic way and will be described in more detail below.

[0031] In the drawings,

[0032] FIG. 1 shows a first exemplary embodiment of a cooktop according to the present invention in a partial vertical sectional side view;

[0033] FIG. 2 shows a first exemplary embodiment of a system according to the present invention in a partial vertical sectional side view, including the cooktop of FIG. 1;

[0034] FIG. 3 shows a diagram illustrating the transmittance of a cooktop plate of a cooktop according to the present invention as a function of the wavelength of the electromagnetic radiation, using the example of a glass-ceramic plate;

[0035] FIG. 4 shows the system of FIG. 2 in a partial perspective bottom view;

[0036] FIG. 5 shows a diagram illustrating the qualitative profile of an output signal of the two heat sensor units as a function of time;

[0037] FIG. 6 shows a second exemplary embodiment of a cooktop according to the present invention in a partial side view;

[0038] FIG. 7 shows a third exemplary embodiment of a cooktop according to the present invention in a partial side view; and

[0039] FIG. 8 shows a fourth exemplary embodiment of a cooktop according to the present invention in a partial side view.

DETAILED DESCRIPTION

[0040] Fig. 1 shows a first exemplary embodiment of a cooktop according to the present invention. Said cooktop includes a cooktop plate 2 which takes the form of a of glass-ceramic plate and which has a material thickness s defined by a flat upper surface 2.1 and a flat lower surface 2.2, in a direction perpendicular to the main directions of extension of said upper and lower surfaces, and which further includes at least one cooking zone 4 that can be heated by a heating means (not shown in FIG. 1) located beneath cooktop plate 2 when the cooktop is in the installed position, and which further has a sensor assembly 6 located beneath cooktop plate 2 and including a first and a second heat sensor unit, of which FIG. 1 shows only first heat sensor unit 6.1. The second heat sensor unit 6.2 is located behind the image plane. First heat sensor unit 6.1 is designed to measure the heat flow emanating downward substantially only from cooktop plate 2 in the area of cooking zone 4, while the second heat sensor unit is designed to measure the heat flow emanating downward substantially from cooktop plate 2

and the cooking utensil placed thereon (not shown in FIG. 1), in the area of cooking zone 4, which will be explained in greater detail hereinafter. In this exemplary embodiment, first and second heat sensor units 6.1, 6.2 each take the form of a thermal radiation sensor unit, the measuring range of first heat sensor unit 6.1 being limited to the measurement of thermal radiation in a first wavelength range, and the measuring range of the second heat sensor unit being limited to the measurement of thermal radiation in a second wavelength range, which is different from the first wavelength range. In the present exemplary embodiment, in order to allow the first heat sensor unit to detect substantially only the thermal radiation that is emitted downward by cooktop plate 2, and to allow the second heat sensor unit to detect substantially the thermal radiation that is emitted downward by cooktop plate 2 and the cooking utensil placed thereon, cooktop plate 2 has a transmittance of less than 20 % for thermal radiation of the first wavelength range, and a transmittance greater than 20 % for thermal radiation of the second wavelength range. Alternatively, it is also conceivable for the first and second wavelength ranges and/or the sensitivity of first and second heat sensor units 6.1 to be selected and thereby adapted to the properties of cooktop plate 2 in such a manner that the transmittance of cooktop plate 2 is approximately 0 % in the first wavelength range and at least about 50 % in the second wavelength range. In this connection, the individual wavelength ranges can be dimensioned very differently, which will be explained hereinafter with reference to FIG. 3.

[0041] The limiting of the measuring ranges of first and second heat sensor units 6.1 to a first and a second wavelength range, respectively, can be accomplished, first of all, by the respective heat sensor having a selective sensitivity itself. Secondly, an optical filter (not shown) can be disposed in the optical path between cooktop plate 2, or the bottom of the cooking utensil, and the heat sensor of the respective heat sensor unit 6.1. This filter can, in principle, be a commercial spectrally selective optical filter, which passes only thermal radiation of the first or second wavelength range, respectively.

[0042] Alternatively, it is also conceivable to use an optical filter which is made of the same material as cooktop plate 2. Furthermore, the aforementioned filter variants for limiting the measuring ranges of the respective heat sensor units could, additionally, be designed as polarizing filters.

[0043] If, in a departure from the aforementioned exemplary embodiment, a cooktop plate 2 is used that is inhomogeneous with respect to transmittance, it is sufficient that in the area of cooking zone 4, cooktop plate 2 has as low a transmittance as possible for thermal radiation, at least in the sensing region of first heat sensor unit 6.1, and as high a transmittance as possible for thermal radiation, at least in the sensing region of the second heat sensor unit, in accordance with the explanations given above. This can be accomplished by replacing the material of cooktop plate 2 in the sensing regions of the first and/or the second heat sensor unit(s) 6.1. A suitable material for this purpose is, for example, aluminum oxide.

[0044] Furthermore, it is conceivable for first heat sensor unit 6.1 to include a contact temperature sensor instead of a heat sensor in the form of a thermal radiation sensor, and to be located, for example, beneath the lower surface 2.2 of cooktop plate 2 in the area of cooking zone 4.

[0045] Also, instead of designing sensor assembly 6 to include two independently usable heat sensor units 6.1, said sensor assembly could be designed such that the two heat sensor units 6.1 have at least some components in common, for example, a shared heat sensor. The then single heat sensor would have to be capable of moving back and forth between two positions in a manner known to those skilled in the art, one of said positions corresponding to the position of the heat sensor of first heat sensor unit 6.1 and the other of said positions corresponding to the position of the heat sensor of the second heat sensor unit of the sensor assembly 6 of the exemplary embodiment mentioned above. Alternatively, it would be possible to use deflector means, such as mirrors or the like, thus allowing the use of a stationary heat sensor.

[0046] The first and second heat sensor units of sensor assembly 6 are in signal communication with an electrical control system, also not shown, which includes a processing unit and a memory. In the processing unit, a comparison value can be generated from the output signals of the first and second heat sensor units 6.1, it being possible for said comparison value to be compared to predetermined reference values stored the memory. The heat output of the heating means can be controlled as a function of this comparison.

[0047] In order to allow the heat output of cooking zone 4 of the cooktop of the present invention to be controlled as accurately as possible, it is necessary to determine the

temperature of the cooking utensil placed on the cooking zone, which is accomplished by the above-explained determination of the comparison value. However, since the temperature of the cooking utensil, or of the bottom of the cooking utensil, also depends on the emissivity thereof, the emissivity of the cooking utensil, or of the bottom of the cooking utensil, must also be specified and stored in the memory, or measured during the cooking process, and made available for processing in the processing unit. In principle, it is possible to use an additional heat sensor unit (not shown in FIG. 1) for this purpose. As an alternative, the present first exemplary embodiment uses the second heat sensor unit for this purpose. To this end, the cooktop according to the present invention further includes a chopper 8, whose structural design will be explained in greater detail with reference to FIG. 4, and a light source 10. The determination of the emissivity of the cooking utensil placed on cooking zone 4, or of the bottom of the said cooking utensil, is also explained in greater detail in the following figure.

[0048] In order to reduce the influence that direct and indirect interfering radiation, for example, from the heating means, has on the output signals of first and second heat sensor units 6.1, the first exemplary embodiment of the cooktop of the present invention includes a hollow conductor 12 which is provided on the inside with a coating, such as a gold film, which reflects the thermal radiation. Alternatively, it is conceivable, for example, to use a sapphire waveguide. Another way to reduce or avoid the influence of interfering radiation on the output signals of the two heat sensor units is to dispose at least one deflector means, such as a mirror or the like, in the optical path from cooktop plate 2 and/or from the bottom of the cooking utensil to the first and/or second heat sensor unit(s) 6.1. In this manner, sensor assembly 6 can be protected from the influence of the interfering radiation mentioned above, either completely or at least to a large extent. In this respect, see also FIG. 8.

[0049] In FIG. 2, the inventive system explained earlier, including the cooktop of the present invention and a cooking utensil 14 placed on cooking zone 4 of cooktop plate 2, is shown in a view rotated 90° with respect to FIG. 1. This representation shows first and second heat sensor units 6.1 and 6.2 of sensor assembly 6. Also shown in FIG. 2 is heating means 16, which is mounted in an insulating member 20 in a generally known manner. Arrows 18 symbolize the above-described direct and indirect interfering radiation from heating means 16. The thermal radiation emanating from cooktop plate 2 and/or from the bottom of the cooking utensil in the area of cooking zone 4 is transmitted in hollow conductor 12 to first

and/or second heat sensor unit(s) 6.1, 6.2 in a manner which is also known per se, as symbolized by arrows 22 in FIG. 2.

[0050] In order to further reduce the influence of the interfering radiation on the input signal of the respective heat sensor unit 6.1, 6.2, an aperture stop can additionally be disposed in the optical path between cooktop plate 2, or cooking utensil 14, and the two heat sensor units 6.1, 6.2, for example, directly in front of the two heat sensor units 6.1, 6.2. Alternatively or additionally, it is also conceivable to mount the two heat sensor units 6.1, 6.2 as close as possible to the lower surface 2.2 of cooktop plate 2.

[0051] FIG. 3 shows a diagram illustrating the transmittance of a cooktop according to the present invention as a function of the wavelength of the electromagnetic radiation, using the example of a glass-ceramic plate. As already explained with reference to FIG. 1, the measuring ranges of first and second heat sensor units 6.1, 6.2 are adapted to the transmittance of the cooktop plate 2 used for the cooktop of the present invention in such a way that the measuring range of first heat sensor unit 6.1 is limited to a first wavelength range for which cooktop plate 2 has a transmittance of less than 20 %, in particular approximately 0%, and that the measuring range of second heat sensor unit 6.2 is limited to a second wavelength range for which cooktop plate 2 has a transmittance greater than 20 %, in particular at least 50 %. In the cooktop plate 2 of the first exemplary embodiment, whose transmittance profile is shown in FIG. 3, by way of example, as a function of the wavelength, the first wavelength range is selected at about 3 μm, and the second wavelength range is selected at about 4 μm. Alternatively, it would also be conceivable to select the first wavelength range to be higher than about 5 μm, and to select the second wavelength range at about 2 μm. Furthermore, in accordance with the present invention, it would be possible for a plurality of wavelength ranges having the transmittance levels mentioned above to be used as input signals for first and second heat sensor units 6.1, 6.2. This would have the advantage of a higher input signal level for the respective heat sensor unit 6.1, 6.2.

[0052] FIG. 4 shows the chopper 8 of FIG. 1 in a detail view, looking at the cooktop of the present invention from below. Chopper 8 has an electric drive unit 8.1 and a circular disk 8.2 disposed between the two heat sensor units 6.1, 6.2 and light source 10 and the hollow conductor 12. A barrier 24, which is roughly shown in FIG. 4, is disposed between the two heat sensor units 6.1, 6.2 and light source 10. In this manner, interfering radiation emanating

from light source 10 is prevented from undesirably influencing heat sensor units 6.1, 6.2. Electric drive unit 8.1 of chopper 8 is in signal communication with the electrical control system of the cooktop of the present invention. During the determination of the emissivity of the bottom of a cooking utensil, said electric drive unit rotates disk 8.2 about an axis of rotation) extending perpendicular to disk 8.2 and through the center thereof. In the area of disk 8.2 that moves over the two heat sensor units 6.1, 6.2 when said disk is rotated, said disk is provided with an elongated slot 8.3, said elongated slot 8.3 having an enlargement 8.3.1 formed at one end thereof. In the area of disk 8.2 that moves substantially over the two heat sensor units 6.1, 6.2 and light source 10 when said disk is rotated, said disk is provided with a reflector 8.4 which takes the form of a mirror and is located on the surface of disk 8.2 facing said components 6.1, 6.2 and 10. Unlike the remaining portion of elongated slot 8.3, enlargement 8.3.1 moves not only over the two heat sensor units 6.1, 6.2 but also over light source 10. In the following, the operation of chopper 8 will be explained in greater detail.

[0053] The operation of the system and cooktop according to the present invention will be explained below in greater detail with reference to FIGS. 1 through 5.

[0054] The cooktop of the present invention is off and a cooking utensil 14 is placed on cooking zone 4. Heating means 16 associated with cooking zone 4 is turned on using a control element not shown in the figures, so that heating means 16 heats up, thus heating cooking zone 4 and cooking utensil 14 placed thereon. Once the cooktop of the present invention has been completely heated to operating temperature, the system begins measuring the thermal radiations emitted substantially downward in the area of cooking zone 4, the measurement being performed using first and second heat sensor units 6.1, 6.2 already explained above, which will be explained by way of example with reference to FIG. 5. FIG. 5 is qualitative in nature and applies to both the first and second heat sensor units 6.1, 6.2 with respect to the general time profile of the output signal. Disk 8.2 of chopper 8 is in a rotational position not shown in FIG. 4, in which disk 8.2 covers the two heat sensor units 6.1, 6.2 as well as light source 10, thus substantially shielding the two heat sensor units 6.1, 6.2 from thermal radiation emitted from hollow conductor 12 toward the two heat sensor units 6.1, 6.2, and from thermal radiation emitted from light source 10 toward the two heat sensor units 6.1, 6.2. Since the electronics and other components disposed on the side of the disk where the two heat sensor units 6.1, 6.2 are located have also been heated up, the input signal received from

each of the two heat sensor units 6.1, 6.2 is not equal to zero when disk 8.2 is in this rotational position; see region a in FIG. 5, which is surrounded by a rectangular frame.

[0055] Disk 8.2 continuously rotates further about the axis of rotation thereof until the rotational position shown in FIG. 4 is reached, where reflector 8.4 of disk 8.2 covers the two heat sensor units 6.1, 6.2 and light source 10. When disk 8.2 is in this rotational position, the thermal radiation emitted by light source 10 is nearly completely deflected by reflector 8.4 toward the two heat sensor units 6.1, 6.2 and received by said heat sensor units as input signals in the respective first and second wavelength ranges; see region b in FIG. 5.

[0056] Disk 8.2 rotates further, and the two heat sensor units 6.1, 6.2 and light source 10 are covered by disk 8.2 again, namely by the region of disk 8.2 between reflector 8.4 and elongated slot 8.3 (see FIGS. 4 and 5, region c), so that the explanations given on region a of FIG. 5 apply to this rotational position of disk 8.2 analogously.

[0057] Disk 8.2 rotates further until elongated slot 8.3 provided in disk 8.2 clears the optical path between cooktop plate 2, or between cooktop plate 2 and the bottom of cooking utensil 14, and the two heat sensor units 6.1, 6.2 in the region of hollow conductor 12. The thermal radiation that cooking plate 2, or cooking plate 2 and the cooking utensil 14 placed thereon, emits/emit downward in the region of cooking zone 4 reaches the two heat sensor units 6.1, 6.2 and is received by said heat sensor units as input signals according to the first and second wavelength ranges, which causes the output signal of each heat sensor unit 6.1, 6.2 to increase to the qualitative value marked d in FIG. 5. In this connection, it should be noted that the value of the output signal of first heat sensor unit 6.1 is somewhat lower than the value of the output signal of second heat sensor unit 6.2, because first heat sensor unit 6.1 receives substantially only the thermal radiation that is emitted downward by cooktop plate 2 alone, while second heat sensor unit 6.2 receives substantially the thermal radiation that is emitted downward by cooktop plate 2 and the cooking utensil 14 placed thereon, in each case in the respective measuring ranges of respective heat sensor units 6.1, 6.2.

[0058] Disk 8.2 rotates further until the other end of elongated slot 8.3, which is provided with enlargement 8.3.1, is reached. When disk 8.2 is in this rotational position, disk 8.2 additionally clears the optical path between light source 10 and hollow conductor 12, so that the thermal radiation emitted by light source 10 is radiated through hollow conductor 12 onto

cooktop plate 2, or onto cooktop plate 2 and the bottom of the cooking utensil, and at least partially reflected therefrom toward the two heat sensor units 6.1, 6.2; see FIG. 5, region e. Therefore, the values of the resulting output signals of the two heat sensor units 6.1, 6.2 are somewhat higher than in the aforementioned region d.

[0059] Disk 8.2 rotates further into a region of disk 8.2 which, analogously to regions a and c explained earlier, shields the two heat sensor units 6.1, 6.2 from the thermal radiation emitted downward by cooktop plate 2, or by cooktop plate 2 and the cooking utensil 14 placed on cooking zone 4; see FIG. 5, region f. The effect exerted by barrier 24 against interfering radiation emitted by light source 10 has already been explained above.

[0060] Disk 8.2 rotates further and the measuring cycle explained above starts again.

[0061] The following is a brief explanation of the analysis of the output signals of the two heat sensor units 6.1, 6.2 in the processing unit of the electrical control system.

[0062] In the processing unit, the output signals of the two heat sensor units 6.1, 6.2 so obtained are used to generate a comparison value, either continuously or at predetermined time intervals, said comparison value being compared in a generally known manner to predetermined reference values stored the memory of the electrical control system. In order to improve the accuracy of the heat output control in the system and cooktop according to the present invention, the emissivity of cooking utensil 14, or of the bottom thereof, is taken into account when the comparison value based on the current measurements made by the two heat sensor units 6.1, 6.2 is compared to the stored reference values. Based on the above-described measurement sequence performed during the cooking process, the emissivity of the bottom of the cooking utensil can be determined in the processing unit in a generally known manner by comparing the output signals of the two heat sensor units 6.1, 6.2 in region b of FIG. 5 to the output signals in regions d and e of FIG. 5. Generally, the output signals of the two heat sensor units 6.1, 6.2 are conditioned for processing in the electrical control system in a manner known to those skilled in the art, for example, using the so-called “lock-in technique”.

[0063] The following further exemplary embodiments and alternatives the first exemplary embodiment mentioned above will be explained only to the extent that they differ from the first exemplary embodiment.

[0064] Instead of using light source 10 for determining the emissivity of the bottom of the cooking utensil, it is also conceivable to use heating means 16, and thus, its otherwise unwanted interfering radiation for the measurement, so that the number of components is further reduced. For this purpose, however, heating means 16 must be briefly turned off during the other measurements, that is, during the measurements of the thermal radiation emitted downward substantially only by cooktop plate 2 in the area of cooking zone 4, and of the thermal radiation emitted downward, in the area of cooking zone 4, by cooktop plate 2 and the cooking utensil 14 placed on cooking zone 4.

[0065] As an alternative to the configuration according to the first exemplary embodiment, the influence of the emissivity of the bottom of the cooking utensil can also be taken into account in the heat output control by using a third heat sensor unit, which is not shown in the figures. For this purpose, the measuring range of the third heat sensor unit is limited to thermal radiation in a third wavelength range, which is different from the second wavelength range, and, in the area of cooking zone 4, at least in the sensing region of the third heat sensor unit, cooktop plate 2 has a transmittance greater than 20 % for thermal radiation of the third wavelength range. Since the temperature of the bottom of the cooking utensil, and thus the level of thermal radiation emitted by the bottom of the cooking utensil, is dependent not only on the wavelength range thereof but also on the emissivity of the bottom of the cooking utensil, it is possible to perform a generally known ratio pyrometer measurement using the second and third heat sensor units, and to thereby determine the increase in the level of thermal radiation over a predetermined wavelength range, which allows the temperature of the bottom of the cooking utensil to be determined, and thus the heat output to be controlled, without determining the emissivity of the bottom of the cooking utensil.

[0066] In particularly simple alternative to the aforementioned options for taking the influence of the emissivity of the bottom of the cooking utensil into account in the heat output control, the bottom of the cooking utensil is provided with a coating, at least in the area that overlaps the sensing region of second heat sensor unit 6.2 when cooking utensil 14 is placed on cooking zone 4, said coating having a predetermined emissivity, which is stored in the memory of the electrical control system.

[0067] In another alternative to the first exemplary embodiment, it is proposed that in the sensing region of first heat sensor unit 6.1, cooktop plate 2 be provided on its upper surface with a coating having a transmittance of approximately 0 %. In one possible implementation, the coating has a reflectance of about 100 %. Thus, first heat sensor unit 6.1 does not need to be configured and adapted to cooktop plate 2 as described in the first exemplary embodiment, because the coating of the present invention, which is not shown in the figures, ensures that, in the area of cooking zone 4, first heat sensor unit 6.1 detects substantially only the thermal radiation that is emitted downward by cooktop plate 2 alone.

[0068] Furthermore, in a possible alternative to the aforementioned option, a coating having an absorptance of about 100 % could be provided on cooktop plate 2 on its upper surface in the sensing region of first heat sensor unit 6.1.

[0069] FIG. 6 shows a second exemplary embodiment of the cooktop according to the present invention. In this exemplary embodiment, a converging lens 26 made, for example, from barium fluoride or aluminum oxide, to provide high temperature resistance is provided in the sensing regions of the two heat sensor units 6.1, 6.2 in a direction from cooktop plate 2 toward the two heat sensor units 6.1, 6.2. Using said converging lens, the thermal radiation emitted downward by cooktop plate 2 and the cooking utensil 14 placed on cooking zone 4 is focused onto first and/or second heat sensor unit(s) 6.1, 6.2 in a generally known manner. In the second exemplary embodiment, moreover, in order for the influence that the thermal radiation emitted downward only by cooktop plate 2 in the area of cooking zone 4 has on the output signal of second heat sensor unit 6.2 to be reduced, so that, therefore, the portion of the thermal radiation that is emitted downward by the bottom of the cooking utensil alone has a greater influence on the output signal of second heat sensor unit 6.2, the material thickness s of cooktop plate 2 is reduced in the sensing region of second heat sensor unit 6.2.

[0070] In a third exemplary embodiment of the inventive teaching, as an alternative to the aforementioned solution, it is conceivable that, at least in the sensing region of second heat sensor unit 6.2, the cooktop plate is designed as a converging lens 26 in a direction from cooktop plate 2 toward second heat sensor unit 6.2; see FIG. 7.

[0071] As explained earlier, FIG. 8 shows a fourth exemplary embodiment of the inventive teaching, where sensor assembly 6 is located in the edge region of the cooktop of the present

invention instead of beneath cooking zone 4. This exemplary embodiment does not use a hollow conductor 12, because deflector means 28, which is disposed in the optical path between cooktop plate 2, or cooking utensil 14, and the two heat sensor units 6.1, 6.2 to deflect the thermal radiation emitted downward, causes the interfering radiation to bypass the two heat sensor units 6.1, 6.2, as symbolized by a dashed arrow 30 in FIG. 8. In contrast to this, the thermal radiation that is emitted downward by cooktop plate 2 alone, or by cooking plate 2 and the cooking utensil 14 placed on cooking zone 4, is directed toward the two heat sensor units 6.1, 6.2 in a manner know to those skilled in the art, as symbolized by a arrows 32 in FIG. 8.

[0072] The aforementioned exemplary embodiments have explained in detail, in particular, the use of chopper 8 as part of the measuring device for determining the emissivity of cooking utensil 14, or of the bottom thereof. Alternatively, however, it is also conceivable to use other types of measuring devices known to those skilled in the art.